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100 Area Soil Washing Treatability Test Plan

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EXECUTIVE SUMMARY

This test plan describes specifications, responsibilities, and general methodology for conducting a soil washing treatability study as applied to source unit contamination in the 100 Area. The objective of this treatability study is to evaluate the use of physical separation systems and chemical extraction methods as a means of separating chemically and radioactively contaminated soil fractions from uncontaminated soil fractions. The purpose of separating these fractions is to minimize the volume of soil requiring permanent disposal.

It is anticipated that this treatability study will be performed in two phases of testing, a remedy screening phase and a remedy selection phase. The remedy screening phase consists of laboratory- and bench-scale studies performed by Battelle Pacific Northwest laboratories (PNL) under a work order issued by Westinghouse Hanford Company (Westinghouse Hanford). This phase will be used to provide qualitative evaluation of the potential effectiveness of the soil washing technology, i.e., whether the technology works or not for the intended application.

The remedy selection phase, consists of pilot-scale testing performed under a separate service contract to be competitively bid under Westinghouse Hanford direction. The remedy selection phase will provide data to support evaluation of the soil washing technology in future feasibility studies for Interim Remedial Measures (IRMs) or final operable unit (OU) remedies. Performance data from these tests will indicate whether applicable or relevant and appropriate requirements (ARARs) or cleanup goals can be met at the site(s) by application of soil washing. The remedy selection tests will also allow estimation of costs associated with implementation to the accuracy required for the Feasibility Study (FS) (+50% to -30%).

In both these phases, PNL and the service contractor selected for the pilot testing phase will prepare detailed instructions and procedures, in accordance with the requirements defined in this test plan, for their respective work scopes. These procedures will then be subject to review and approval by Westinghouse Hanford prior to initiation of actual testing work in each phase of the study.

The 116-D-1B and 116-C-1 Waste Disposal Trenches were chosen as the test sites for the soil washing treatability study. Site contaminants are principally chromium and radionuclides. Soils from both sites will be tested in the remedy screening phase. Completion of this phase satisfies the treatability study milestone established in the approved Remedial Investigation/Feasibility Study (RI/FS) work plan for the 100-BC-1 operable unit. The subsequent remedy selection phase will only test soil from one site unless the contamination characteristics of the soils are found to be significantly different between the two sites. If significantly different, soils from both sites will be tested. Completion of the remedy selection phase satisfies the treatability study milestone established for the 100-DR-1 operable unit.

Following the remedy screening studies, a cost/benefit analysis will be performed by Westinghouse Hanford to assess the overall technical and economic viability of the soil washing process relative to its benefit in reducing soil waste volume requiring disposal. This cost/benefit analysis, using data provided by the remedy screening study, will form the basis for a go/no-go decision on proceeding with the remedy selection pilot-scale testing. In the event that a pilot-scale study is not warranted, a contingency treatability study will be conducted as agreed to by the parties of the Tri-Party Agreement. If necessary, details of this test will be provided in a separate test plan to be prepared at a later date.

Soil washing is an ex situ treatment process that involves the removal of contaminants from soils using combinations of classification (by particle size), mechanical scouring (attrition scrubbing), and/or chemical leaching. There are two types of soil washing - physical separation and chemical extraction. In physical separation (referred to as physical soil washing), water is used as a medium for physically separating soil into size fraction ranges, or classifying it. Chemical extraction uses chemical reagents to remove (leach) contaminants from the soil matrix. Chemical extraction can be performed in two types of processes: 1) by mechanically mixing soil and extractant in a continuous reactor and 2) by percolation of extractant through a fixed bed of soil. The first type of chemical extraction is referred to as chemical soil washing, the latter is referred to as heap leaching.

In the remedy screening phase of testing, wet screening and attrition scrubbing will be tested to determine the effectiveness of physical soil washing. Chemical extraction, both in mechanically mixed and heap leaching modes, will be tested to determine the effectiveness of these techniques.

The remedy screening phase is subdivided into two stages:

- Stage I consists of a series of small laboratory-scale, screening level tests of wet screening, attrition scrubbing, and mechanically mixed chemical extraction. Stage I includes testing of a wide variety of process conditions to determine which show promise in achieving the volume reduction objectives.

- Stage II will then test the most promising process types and conditions determined in Stage I to optimize and verify the more effective conditions. The testing in this phase will be performed on a lab- or bench-scale, the scale to be determined by the test contractor. The objective of these tests is to identify the optimum combination of chemical and physical treatments to maximize volume reduction of the original soil mass. The Stage II tests will also investigate heap leaching and wash water treatment. Heap leaching will be tested in bench-scale extraction columns. Wash water treatment studies will be conducted in lab- and bench-scale to evaluate chemical reduction/precipitation and ion exchange technologies for removal of contaminants from wash water and/or spent chemical solutions. Recycle of treated wash water and/or chemical extractants will be investigated.

At the completion of the remedy screening phase, a screening report describing the results of this testing will be submitted, the cost/benefit analysis will be performed, and, if warranted, the study will proceed to the remedy selection phase.

The remedy selection phase of the treatability testing is an on-site pilot-scale demonstration of the integrated soil washing process. All components of the soil washing treatment train will be tested. This will include feed preparation, soil washing, and treatment or containment of all process residuals (such as contaminated ion exchange resins, water treatment sludges, and residual soil fines).

The pilot-scale system will, based on the results of the remedy screening testing, combine the best physical separation and chemical extraction processes into an integrated process system. The system will be designed to process soil on a continuous basis at approximately 10 to 20 tons/hour and will provide sufficient flexibility for testing a number of combinations or sequences of physical and chemical separation steps. Performance data can then be obtained for different process alternatives so that comparative engineering evaluations can be made.

The principal objectives of pilot-scale testing are to demonstrate that treated soil from the selected process can consistently meet the performance limits for the contaminants of concern and to demonstrate the overall volume reduction that can be achieved with the optimized system. The pilot-scale testing will also demonstrate operational reliability and provide scale-up data for design of full-scale (> 100 tons/hr) systems. Operating data will be obtained for the purpose of assessing utility requirements, characteristics of process residuals, emissions, and environmental impacts.

A treatability test report will be prepared following the remedy selection testing phase. The final report will incorporate results from both the remedy screening and selection phases.

The remedy screening phase will be initiated in early FY 1993. The milestone date for completion of the remedy screening phase is November 1993 with a report issued to the regulators by January 1994. Test activities for the remedy selection phase will be completed by August 1994.

ACRONYMS

ARAR	Applicable, or Relevant and Appropriate Requirement
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program
CEC	Cation Exchange Capacity
CFR	Code of Federal Regulations
CRP	Community Relations Plan
CY	Calendar Year
DOE-RL	Department of Energy, Richland Operations Office
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DQO	Data Quality Objective
Ecology	Washington State Department of Ecology
EII	Environmental Investigation Instruction
EPA	U.S. Environmental Protection Agency
FFS	Focused Feasibility Study
FS	Feasibility Study
FSP	Field Sampling Plan
FY	Fiscal Year
HPT	Health Physics Technician
HSL	Hazardous Substances List
HSP	Health and Safety Plan
HSPPS	Hanford Site Past-Practice Strategy
HWOP	Hazardous Waste Operations Permit
IRM	Interim Remedial Measure
LDR	Land Disposal Restriction
LFI	Limited Field Investigation
MCL	Maximum Contaminant Level
MTCA	Model Toxics Control Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PNL	Pacific Northwest Laboratory
QA	Quality Assurance
QAPjP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
RESRAD	Residual Radioactivity Program
RFP	Request for Proposal
RFI/CMS	RCRA Facility Investigation/Corrective Measures Study
RI	Remedial Investigation
RP	Responsible Party

ACRONYMS (cont)

RWP	Radiation Work Permit
SAP	Sampling and Analysis Plan
SDWA	Safe Drinking Water Act
TBC	To be considered
TCLP	Toxicity Characteristic Leaching Procedure
TOC	Total Organic Carbon
WHC	Westinghouse Hanford Company
WIDS	Waste Information Data System

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FIGURES:

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1.0 INTRODUCTION

The 100 Area of the Hanford Site (see Figure 1-1) is included on the EPA's National Priorities List (NPL) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Nine water-cooled reactors were operated in the 100 Area for plutonium production. Eight of these reactors (B, C, D, DR, F, H, KE, and KW) have been retired from service and are under evaluation for decommissioning. The ninth reactor, N, was recently taken out of standby status and will be retired.

Waste disposal practices associated with reactor operations resulted in substantial releases of contamination to both soil and groundwater media in the vicinity of the reactors. Most of the contamination resulted from disposal of cooling water containing low concentrations of radionuclides. Significant volumes of soil and underlying groundwater have become contaminated as a result of leaks in the spent cooling water transfer systems and the intentional water disposal in cribs and trenches. In addition, solid wastes contaminated primarily with radionuclides were buried in unlined trenches.

Since shutdown of the production reactors, limited environmental investigations have been performed to characterize the nature and extent of the contamination. Additional field investigations are currently underway to supplement prior characterization data for the purpose of screening and selection of remedial actions. Development and screening of remedial alternatives for the 100 Area, using existing data, have been completed and are documented in the *100 Area Feasibility Study, Phases 1 and 2* (DOE-RL 1992a). In addition, based on the results of this Feasibility Study (FS), the *Treatability Study Program Plan* (DOE-RL 1992b) identifies and prioritizes treatability studies for the 100 Area needed to support future focused feasibility studies (FFS) for Interim Remedial Measures (IRMs) and for operable unit (OU) final remedy selection.

One of the high priority, near-term, treatability study needs identified in the treatability study program plan is soil washing. As discussed in the FS, the largest fraction of contaminated material requiring remediation is contaminated soil. Among the alternatives for remediating contaminated soil is removal of the soil and disposal at an on-site engineered disposal facility. Because of the large soil volumes involved, soil washing to reduce the volume requiring disposal may have significant technical and cost advantages. However, additional performance data on soil washing are needed before a more definitive analysis of the technology, as part of the integrated remedy, can be undertaken. Further, should testing prove the technology to be technically and economically viable, data will ultimately be needed to support design of soil washing systems.

This test plan describes specifications, responsibilities, and the general methodology for conducting a soil washing treatability study. The objective of this treatability study is to evaluate the use of physical separation systems and chemical extraction methods as a means of separating chemically and radioactively contaminated soil fractions from uncontaminated soil fractions.

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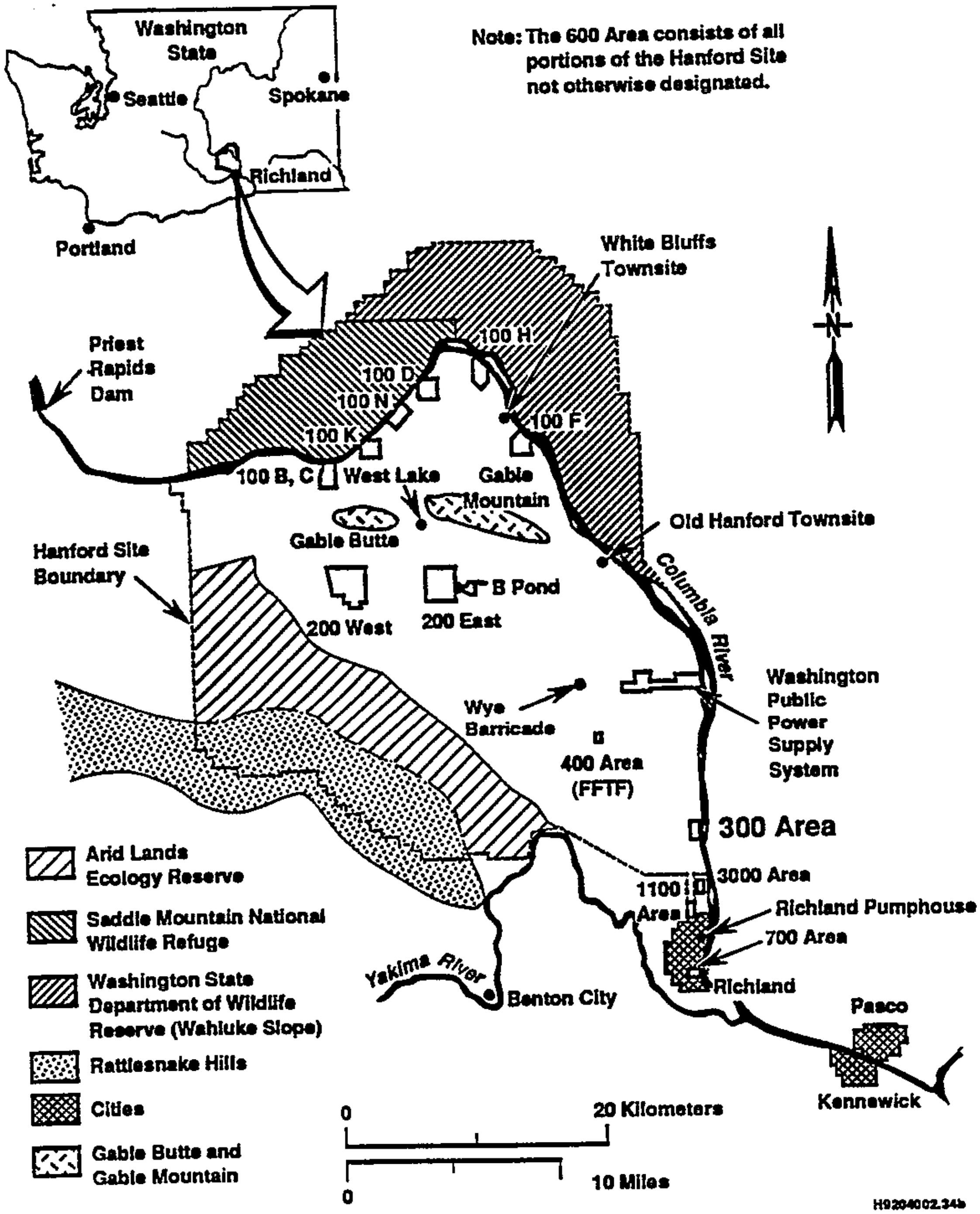

Figure 1-1. Hanford Site

This treatability study will be performed in two phases. The first phase being laboratory- and bench-scale studies to be performed by Battelle Pacific Northwest laboratories (PNL) under a work order issued by Westinghouse Hanford Company (Westinghouse Hanford). The second phase, consisting of pilot-scale testing, will be performed under a separate service contract to be competitively bid under Westinghouse Hanford direction. In both phases, PNL and the service contractor (selected for the pilot testing phase) will prepare detailed instructions and procedures, in accordance with the requirements defined in this test plan. These procedures will then be subject to review and approval by Westinghouse Hanford and the Department of Energy (DOE) prior to testing with informal input by EPA and Ecology.

A pilot-scale physical soil washing treatability test is planned for the 300 Area and will be initiated in Fiscal Year (FY) 1993 (DOE-RL 1992c). The contaminants of concern for the 300 Area are significantly different than the 100 Area, such that the results of the 300 Area testing will not provide sufficient information to fulfill the objectives of the 100 Area tests. However, 300 Area testing may produce general process information which will be useful in planning or implementing pilot-scale testing in the 100 Area. Therefore, information from the 300 Area test will be reviewed and incorporated into the 100 Area soil washing tests where applicable.

This test plan has been developed in accordance with guidance provided in the *Guide for Conducting Treatability Studies Under CERCLA*, (EPA 1989a).

1.1 PURPOSE AND SCOPE

Treatability studies are one of the primary components of the Remedial Investigation/Feasibility Study (RI/FS) process, providing the critical performance and cost information needed to evaluate and select treatment alternatives through the FS process. Treatability studies are also used to provide critical design information necessary to implement the selected remedy.

Treatability studies are performed in three progressive phases, remedy screening, remedy selection, and remedy design. The scope of this test plan includes the remedy screening and selection phases for soil washing. The remedy screening phase will be used to provide qualitative evaluation of the effectiveness of the soil washing technology, i.e., whether the technology works or not for the intended application. The remedy selection phase will provide data to support evaluation of the soil washing technology in future feasibility studies for IRMs or final OU remedies. Performance data from these tests will indicate whether applicable or relevant and appropriate requirements (ARARs) or cleanup goals can be met at the site(s) by application of soil washing. The remedy selection tests will also allow estimation of costs associated with implementation to the accuracy required for the FS (+50% to -30%). The remedy design phase is performed to optimize the selected treatment process and to obtain detailed cost and performance data needed to design a full-scale soil washing system. Remedy design testing is not within the scope of this treatability study.

The purpose of this test plan is to document the functional and process requirements for conducting soil washing treatability tests.

The scope of the test plan includes defining the following:

- Technology to be tested
- Goals, test, and data quality objectives
- Specific tasks for the treatability test
- Organizational responsibilities
- Test schedule.

Test details are outside the scope of this test plan and will be provided by the treatability test contractors prior to initiating actual test work.

1.2 SOIL WASHING TECHNOLOGY DESCRIPTION

Soil washing is an ex situ treatment process that involves the removal of contaminants from soils using combinations of classification, mechanical scouring, and/or chemical leaching. There are two types of soil washing - physical separation and chemical extraction. In physical separation (referred to as physical soil washing), water is used as a medium for physically separating, or classifying, soil into size fraction ranges. Chemical extraction uses agents to remove (leach) contaminants from the soil matrix. Chemical extraction can be performed in two types of processes: 1) by mechanically mixing soil and extractant in a continuous reactor and 2) by percolation of extractant through a fixed bed of soil. The first type of chemical extraction is referred to as chemical soil washing, the latter is referred to as heap leaching.

More detailed descriptions of soil washing process options are given in the subsections below.

1.2.1 Physical Soil Washing

Physical soil washing as a contaminant separation method is particularly suited to soils which are predominantly sand and gravel. It is based on the principle that the contaminants are associated primarily with soil components finer than about 200 mesh (0.075 mm), including fine silts, clays, and soil organic matter. Hanford soils are well suited to physical soil washing, being predominantly coarse basaltic and granitic sands and gravels, with less than 10% silts and clays. In the 300 Area of the Hanford Site, a majority of contaminants are in the form of coatings or particulates residing on or within soil particles less than 100 microns in diameter (Gerber et al., 1991). This may also be the case in the 100 Area, but will not be known until further characterization is performed. Attrition scrubbing may also be used in conjunction with physical washing to enhance the separation of contaminants which adhere to the surface of larger particles. By abrading the larger particles, separation efficiency may be enhanced. Attrition scrubbing also disintegrates or breaks up soil aggregates resulting in the liberation of the fine particles from the coarser sand and gravel.

Physical washing of the 100 Area soils may be successful if the contaminants can be liberated from the coarse particles and concentrated in the fines, and if a clean separation can be achieved. If this is achievable, then (based on the size distribution of soils) it is estimated that the contaminated soil volume could be reduced by 80% or more. The clean fractions that meet cleanup limits (i.e., materials with contaminant concentrations below performance levels) would be returned to their original locations as excavation backfill. The contaminated fine fractions would be disposed at the on-site engineered disposal facility (currently contemplated for the 200 Area). Stabilization of contaminated fractions might be necessary prior to disposal if contaminant concentration levels exceed land disposal restrictions. Wash water would be recycled. Some wash water may also require purging from the recycle loop and treatment, to remove contaminants, thereby keeping contaminant concentrations in the recycle loop within acceptable limits.

Physical soil washing is used extensively in the mining and mineral processing industries to assist in the recovery of valuable constituents. These physical separation processes have also been demonstrated by: the EPA Superfund Innovative Technology Evaluation Program (SITE) for hazardous waste remediation (EPA 1989b) and the Defense Nuclear Agency for cleanup of radiologically contaminated coral sands (Kochen 1986). Currently, a similar study is being conducted at the Fernald Environmental Management Project (DOE 1992). The EPA *Engineering Bulletin* "Soil Washing Treatment" (DOE 1990a) also provides additional information on this process.

Many separation systems are commercially available. A schematic of a conceptual soil washing system is shown in Figure 1-2. This example system consists of a grizzly to screen out and wash material larger than about 100 mm in diameter, an attrition scrubbing unit to abrade contaminants from larger particles (cobbles, gravel, and sand), a trommel or high pressure water spray to wash and screen material larger than 6 to 8 mm in diameter, a classifier (gravity or hydraulic separation), a dewatering system consisting of a clarifier and filter, and a wash water treatment and recycle system. Washed coarse material is returned to the excavation site for use as backfill. Soil fines and water treatment residuals are shipped to the on-site disposal facility. Fines and residues are stabilized, if necessary, prior to disposal.

1.2.2 Chemical Soil Washing

Chemical extraction is one of the oldest technologies in the chemical industries, used predominantly in the metallurgical industries for extracting valuable minerals from large quantities of ore. Chemical extraction is also used in many industries for processes ranging from caffeine extraction to crystal production.

Chemical solutions used in extraction may include acidic or basic aqueous solutions, or aqueous solutions containing complexants, chelating agents, reducing or oxidizing agents, or surfactants.

A typical chemical extraction system is shown schematically in Figure 1-3. The system consists of a reaction vessel where the soil to be washed and extractant contact each other for the required period of time. The mixture is agitated to maximize the solid-liquid

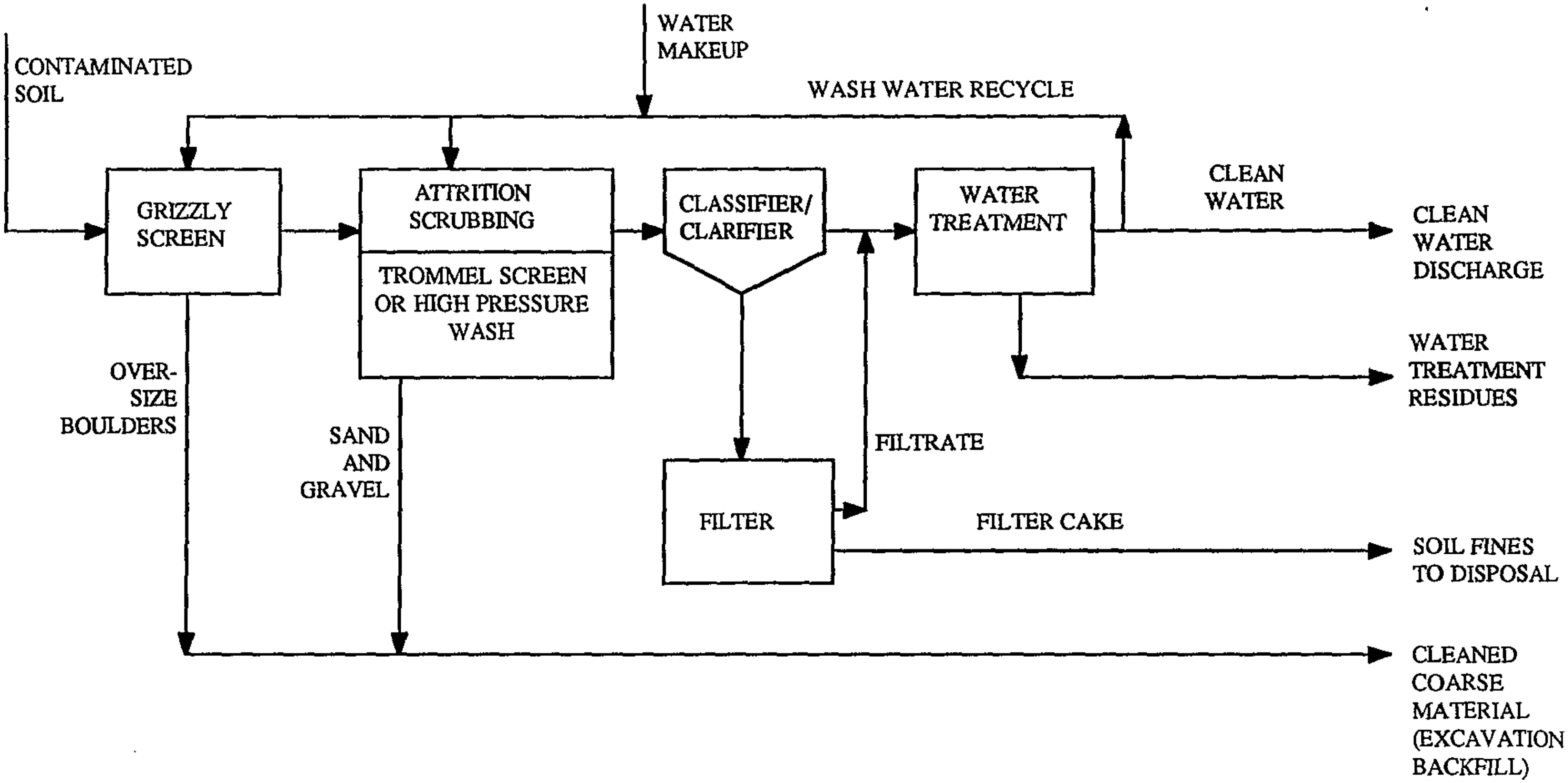

Figure 1-2. Typical Physical Separation System for Soils

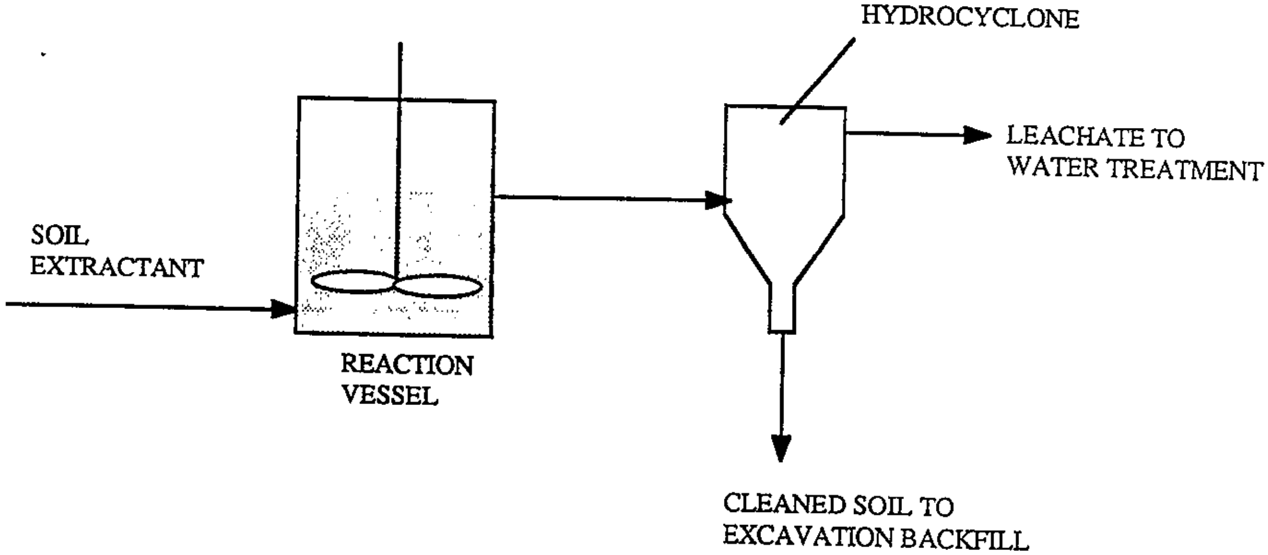

Figure 1-3. Typical Chemical Extraction System

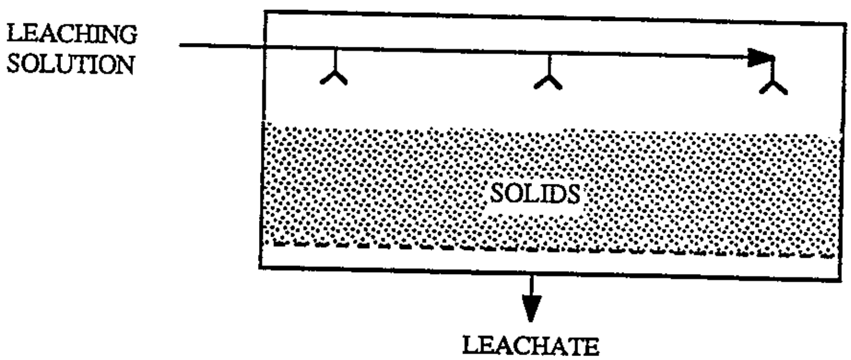

Figure 1-4. Typical Heap Leaching System

contact. The leachate/soil stream flows to a separation unit such as a hydrocyclone where the soil particles settle to the bottom and are removed as a slurry. The leachate is further treated to remove contaminants and the resulting cleaned chemical solution is recycled to maximize chemical utilization. The cleaned soil slurry is dewatered, rinsed to remove residual extractant, and returned to the excavation site for use as backfill. The process may be performed in continuous, batch, or staged batch modes depending on the specific process objectives.

1.2.3 Heap Leaching

In heap leaching, the entire soil matrix is placed in a vessel and the leaching solution is percolated through the soil. The leaching solution, removed from the bottom of the vessel, is then further treated for contaminant removal. The treated leaching solution may be recycled to maximize chemical utilization. In contrast to mechanical washing, heap leaching is by nature a simpler approach because less mechanical equipment is involved. While mechanically much simpler, the cost savings in mechanical equipment may be offset by the increased chemical costs. Because heap leaching works on the whole soil matrix, including fines, chemical usage is higher. Also, the process is inherently less efficient because the solid/liquid contact is not as good as in the mechanical washing systems.

Heap leaching is widely used commercially, especially in the mining and minerals industry. Its use in hazardous waste site remediation is not as common. Figure 1-4 shows a schematic of a typical heap leaching system.

1.3 TEST SITE

The *Treatability Study Program Plan* (DOE-RL 1992b) documents the methodology used to identify and select the test sites for treatability studies. The 116-D-1B and 116-C-1 Waste Disposal Trenches were chosen as the test sites for the soil washing treatability study for the following reasons:

- They are representative of a number of similar sites in the 100 Area
- They contain a variety of contaminants over a range of concentrations
- They are likely candidates for IRMs.

Two waste sites were selected rather than one to assess performance of soil washing relative to differences in contamination sources, i.e., the 116-D-1B trench is contaminated from fuel storage basin water while the 116-C-1 trench is contaminated directly from reactor cooling water.

The 116-D-1B Waste Disposal Trench resides within the 100-DR-1 OU. The trench received contaminated water and sludge from the fuel element storage basins located inside the 118-D-6 reactor building. In these basins, ruptured fuel elements contaminated the cooling water as well as the sludge that deposited in the bottom of the basin. In the 1950s, sludge was pumped from the fuel storage basin into both the 116-D-1A and 116-D-1B trenches (Dorian and Richards 1978). One or both of these trenches also received decontamination waste from the 108-D facility. The 116-D-1B trench is 30 m (100 ft) long, 3 m (10 ft) wide, and 5 m (15 ft) deep, and was covered with clean soil in 1967 (DOE-RL 1991a). Trench contamination is discussed in Section 1.3.1.1 below.

The 116-C-1 Waste Disposal Trench resides within the 100-BC-1 OU. This trench is unlined and is 152 m (500 ft) long, 15 m (50 ft) wide, and 5 m (16 ft) deep. It was used from 1952 until 1958 and received an estimated 700 million liters (26 million gallons) of high-activity cooling water diverted from the 116-C-5 retention basin.

1.3.1 Site Contaminants

Contamination of the 116-D-1B and 116-C-1 trenches is expected from near ground surface down to the water table, although contamination is expected to be more concentrated within the first few feet below the trench bottom. Soil characteristics are similar for both trenches because both consist of Hanford formation soils (Lindsey 1992).

Soils from both sites will be tested in the remedy screening phase of the treatability study. If the differences in soils at the two sites are found to be insignificant, then soil from only one site will be tested in the remedy selection phase.

1.3.1.1 116-D-1B Contaminants of Concern. Based on Dorian and Richards (1978) and a review of operating practices in the 100-DR-1 OU (DOE-RL 1991b), a list of potential contaminants of concern specific to the 116-D-1B trench was generated. Table 1-1 lists the contaminants of concern (as reported in the 100-DR-1 RCRA Field Investigation/Corrective Measures Study (RFI/CMS) work plan (DOE-RL 1991b) and Dorian and Richards (1978)) and their performance levels. The performance levels are based on potential ARARs and To Be Considered (TBC) standards (where no potential ARARs exist). The performance level for radionuclides is the maximum level of radionuclides allowed in soil before it is classified as a radioactive material for on-site disposal (WHC 1988a). The intent of these limits is to assure that the individual effective dose equivalents do not exceed 25 mrem/year total for direct soil exposure, under any reasonable situation, or 4 mrem/yr from drinking water. The 4 mrem/yr dose limit is also the basis for the Maximum Concentration Level (MCL) for radionuclides under the Safe Drinking Water Act (SDWA) and is based on a 10^{-6} excess cancer risk (40 CFR 300.430). Table 1-1 does not include ^{106}Ru because its half-life is less than or equal to 2 years. This radionuclide was removed from the 100 Area Feasibility Study contaminants of concern list (DOE-RL 1992a) because it is no longer present at significant levels in the 100 Area.

There are few data on non-radioactive contaminants. Sodium dichromate was routinely added to the cooling water. Stenner et al. (1988) lists three chemicals disposed of to the 116-D-1B trench (sodium dichromate, sodium formate, and sodium sulfamate).

TABLE 1-1
CONTAMINANTS OF CONCERN FOR THE 116-D-1B TRENCH

Radionuclides[1]	Value Detected[2]		Performance Level[3]
	Average[4] (pCi/g)	(Ci)	(pCi/g)
^{3}H	14	0.20	35,000
^{60}Co	14	0.20	1
^{90}Sr	14	0.20	13
^{134}Cs	0.35	0.0049	2
^{137}Cs	44	0.62	3
^{152}Eu	31	0.43	3
^{154}Eu	5.9	0.083	3
^{155}Eu	63	0.88	100
^{235}U	0.18*	0.0025*	15
^{238}U	*	*	50
$^{239/240}Pu$	0.48	0.0067	75

Chemical Contaminants[7]	Volume of Chemical Disposed to the Trench kg(lb)	Performance Level[6] ppm
Chromium (total)	700 (1540)[5]	1600

1. Based on sampling data and disposal history (DOE-RL 1991b, Dorian and Richards 1978, DOE-RL 1991a)
2. Adapted from Dorian and Richards (1978).
3. Accepted upper limit of radioactive material concentrations for soils (WHC 1988a, Table K-1)
4. Averages are arithmetic averages of individual analytical results.
5. As sodium dichromate (Stenner et al., 1988) Stenner also indicates that 2,000 kg (4,400 lb) each of sodium formate and sodium sulfamate were disposed into the trench. WIDS (DOE-RL 1991a) reports that 2,000 kg of sodium oxalate rather than sodium formate was disposed into the trench.
6. Value based on Method B of WAC 173-340-740(3)(a)(iii)(A)
7. Based on disposal history (DOE/RL 1991b, DOE-RL 1991a)

* Measured as total uranium (Dorian and Richards 1978)

Note: All radionuclide data are 1976 analytical data, radioactive decay to the present time has not been considered. Dimensions used by Dorian and Richards (1978) for volume and mass calculations of the 116-D-1B trench:
Volume = 150 ft x 40 ft x 35 ft = 2.1×10^{5} ft^{3}
Mass = 1.4×10^{10} g

1.3.1.2 116-C-1 Contaminants of Concern. The 116-C-1 Liquid Waste Disposal Trench was sampled extensively in 1975 and the results reported in Dorian and Richards (1978). Contamination was found beneath the trench along the entire length, and consisted primarily of the following radionuclides:

- ^{90}Sr
- ^{60}Co
- ^{152}Eu
- ^{154}Eu
- ^{137}Cs.

In many of the borings, concentrations of radionuclides were still increasing at depths of 30 to 36 feet, indicating that the limits of the contaminated soil column may not have been reached (DOE-RL 1991b).

Based on the work of Dorian and Richards and a review of operating practices in the 100-BC-1 OU (DOE-RL 1991c), a list of potential contaminants of concern specific to the 116-C-1 trench was generated. Table 1-2 lists the contaminants of concern for the 116-C-1 trench and their performance levels. Performance levels have the same basis as discussed in Section 1.3.1.1 above.

There are few data on non-radioactive contaminants. The Waste Information Data System (DOE-RL 1991a) lists only one chemical disposed of to the 116-C-1 trench, sodium dichromate.

1.4 FULFILLMENT OF MILESTONES

Completion of remedy screening tests satisfies the treatability study milestone established in the approved RI/FS work plan for the 100-BC-1 operable unit. Completion of the remedy selection tests satisfies the treatability study milestone established for the 100-DR-1 operable unit.

2.0 TEST PERFORMANCE AND DATA QUALITY OBJECTIVES

The remedy screening studies will provide the necessary process data from which to evaluate the viability of physical methods, chemical methods, or combinations thereof, and to make a selection of process conditions for testing in subsequent pilot-scale studies. The testing and evaluation of equipment systems are not objectives of the remedy screening studies.

**TABLE 1-2
CONTAMINANTS OF CONCERN FOR THE 116-C-1 TRENCH**

Radionuclide[1]	Value Detected[2]		Performance Level[3]
	Average[4] (pCi/g)	(Ci)	(pCi/g)
^{3}H	7.5	1.4	35,000
^{60}Co	180	32	1
^{90}Sr	11	2.0	13
^{134}Cs	2.2	0.4	2
^{137}Cs	39	7.0	3
^{152}Eu	130	23	3
^{154}Eu	67	12	3
^{155}Eu	6.8	1.2	100
^{235}U	0.2*	0.0036*	15
^{238}U	*	*	50
$^{239/240}Pu$	0.74	0.13	75
Chemical Contaminants[5]		**Volume of Chemical Disposed to Trench kg(lb)**	**Performance Level[6] ppm**
Chromium (total)		100 (220)[7]	1600

1. Based on sampling data and disposal history (DOE/RL 1991c, Dorian and Richards 1978, DOE-RL 1991a)
2. Adapted from Dorian and Richards (1978).
3. Accepted upper limit of radioactive material concentrations for soils (WHC 1988a, Table K-1)
4. Averages are arithmetic averages of individual analytical results.
5. Based on disposal history (DOE/RL 1991c, DOE-RL 1991a)
6. Values based on Method B of WAC 173-340-740(3)(a)(iii)(A)
7. As sodium dichromate (DOE-RL 1991a)

* Measured as total uranium (Dorian and Richards 1978)

Note: All data are 1976 analytical data; radioactive decay to the present time has not been considered. Dimensions used by Dorian and Richards (1978) for volume and mass calculations of the 116-C-1 trench are:
Volume = 600 ft x 150 ft x 30 ft = 2.7×10^{6} ft^{3}
Mass = 1.8×10^{11} g

2.1 TEST PERFORMANCE OBJECTIVES

The objective of this treatability study is to determine whether soil washing can reduce the volume of contaminated 100 Area soils in a cost-beneficial way. Volume reduction will be achieved by cleaning some or all soil fractions sufficiently to allow them to be returned to the environment. To be returned to the environment, the cleaned fraction must meet the minimum performance levels listed in Tables 1-1 and 1-2. In addition to this requirement, for the purpose of personnel safety, residual radioactivity in the cleaned material shall not result in radiation exposure rates greater than 20 micro-R/hr above background exposure rates (DOE 1990b). After testing is complete, a cost benefit analysis will be used to determine the minimum beneficial volume reduction. The minimum beneficial volume reduction is defined as the point where the cost of cleaning the soil equals the cost savings from not disposing of the cleaned soil. If the cost-beneficial volume reduction is possible, then the technology is applicable to cleanup of contaminated soils in the 100 Area.

Test objectives for each of the individual tests are defined in Table 2-1. Design of the tests is described in Section 4.0.

2.2 COMPARISON LEVELS

The test results will be compared against potential ARARs and cleanup standards as follows:

- EPA proposed corrective action health-based standards (40 CFR 264, Subpart S (proposed))
- Dangerous Waste Designation Limits (WAC 173-303-070)
- Land Disposal Restrictions (40 CFR Part 268)
- Model Toxics Control Act (MTCA) Residential Standards (WAC 173-340-740(3))
- Residual Radioactivity Levels (RESRAD Code[1])
- Groundwater Cleanup Limits (WAC 173-340-720)
- Drinking Water Standards (40 CFR Part 141 and 143)
- Ambient Water Quality Criteria for Freshwater Chronic Toxicity (40 CFR).

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[1] A DOE computer code to calculate compliance with RESidual RADioactive material guidelines. Developed at the Environmental Assessment and Information Sciences Division of Argonne National Laboratory.

TABLE 2-1
TEST OBJECTIVES

Test Section	Objective
Remedy Screening (Laboratory/bench-scale) Stage I	
Physical Separation	Determine if contamination resides in specific fractions
Attrition Scrubbing	Determine if larger particles have contaminant coatings that can be abraded away
Chemical Extraction	Determine amount of contaminants that can be extracted from the soil and which extractants work best
Stage II	
Soil Washing Process Optimization	Determine if best methods from Stage I testing will work on other size fractions, under more realistic conditions, and/or as combined processes.
Soil Washing Process Verification	Verify most promising processes from process optimization.
Heap Leaching	Determine if the best chemical extractants will work using a heap leach approach
Wash Water Treatment	Determine best method for treating wash water from Stage II process verification tests
Remedy Selection (Pilot-scale)	Demonstrate system reliability and performance, utility requirements, emissions and environmental impacts, and scale-up. Demonstrate secondary waste handling and treatment. Optimize integrated process systems and conditions.

2.3 DATA QUALITY OBJECTIVES

To ensure that the correct level of detail and data quality is achieved for evaluating soil washing, data quality objectives (DQOs) will be identified based on guidance given in *Data Quality Objectives for Remedial Response Activities (Development Process)* (EPA 1987).

The primary data users include:

- DOE, EPA, and Ecology remedial project managers
- DOE, EPA, and Ecology Unit Managers
- Westinghouse Hanford Remedial investigation (RI) and feasibility study (FS) coordinators

The data will be used to support final remedial decisions, including:

- Site characterization
- Occupational health and safety
- Risk assessments
- Alternatives evaluation (remedy screening and selection)
- Remedy design
- Monitoring during remedial actions.

Test data will be of sufficient quality and type to answer the following questions (at a minimum):

<u>Remedy Screening (Laboratory/Bench-scale Testing)</u>

- What is the size distribution of soil particles?

- To what degree are the coarse fractions separated from the fines by wet screening?

- Where does the contamination reside in the soil fractions?

- Are agglomerates well dispersed in the initial attrition scrubbing operation? If not, what means are necessary to ensure adequate separation of agglomerated material?

- Are there surface coatings that can be abraded away?

- What, if any, chemical treatment is required to decontaminate the soil fractions?

- What chemical additives are needed and what are their volumes and concentrations for final treatment?

- Can heap leaching clean the entire soil matrix?
- What are the optimum conditions for particle size separation, attrition scrubbing, chemical extraction, and heap leaching?
- To what extent do soluble contaminants/chemicals build up in the treatment water?
- What treatment may be required for contaminated wash water?
- What treatment may be required for contaminated fines?

Remedy Selection (Pilot-scale Testing)

- Will the treated soil from the selected process consistently meet the performance limits for the contaminants of concern?
- What is the overall volume reduction achieved?
- Can wash water and/or extraction solutions be recycled?
- What are the requirements for the waste water treatment system?
- Is the equipment selected for the soil washing system mechanically reliable?
- What factors are associated with the process equipment to allow confident scale-up to a full-scale system (e.g., >100 tons/hr)?
- Is decontamination of the oversize material that was too large to be studied in the laboratory- and bench-scale tests necessary and if so how will it be accomplished?
- What are the operating utility requirements (e.g., chemical consumption, power, and water)?
- What are the characteristics of the process residuals?
- What are the emissions and/or environmental impacts?

All Stage I tests and Stage II soil washing process optimization tests are laboratory- and bench-scale screening tests and require less stringent DQOs than the laboratory-/bench-scale Stage II process validation tests and the pilot-scale remedy selection tests.

3.0 POTENTIALLY APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Section 121(d) of CERCLA, as amended, requires that remedial actions at National Priorities List sites comply with federal and state environmental laws and regulations. This requirement is reiterated in Subpart E of the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR Part 300), which establishes when and by whom the ARARs must be identified.

Potential ARARs are those substantive, promulgated federal and state environmental requirements that are pertinent to a remedial action. ARARs may specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at the site; or they may be otherwise relevant and appropriate by addressing problems or situations sufficiently similar to those encountered at the site. Only those state standards that are promulgated, are identified by the state in a timely manner, and are more stringent than federal requirements may be applicable or relevant and appropriate (40 CFR 300.400(4)).

In addition to ARARs, TBC information is also important to remedial planning, and TBCs are included in the evaluation of ARARs. TBCs are non-promulgated criteria, advisories, guidance, and proposed standards that are not legally binding but may provide useful information or recommended procedures. TBCs may be used in the absence of ARARs or where ARARs are not sufficiently protective for developing cleanup goals. TBCs identified for these 100 Area sites include U.S. Department of Energy (DOE) Orders and county requirements.

Table 3-1 lists the potential chemical-, location-, and action-specific ARARs and TBCs that may be relevant to the 100 Area Soil Washing Treatability Test. These were taken from the ARARs and TBCs identified and discussed in the *100 Area Feasibility Study (FS) Phases 1 and 2* (DOE-RL 1992a). A more through discussion is included in the FS.

4.0 SOIL WASHING EXPERIMENTAL DESIGN AND SPECIFICATION

The following subsections describe the soil washing experimental design for treatability testing of the 116-C-1 and 116-D-1B soils.

4.1 SOIL WASHING EXPERIMENTAL DESIGN

The soil washing treatability testing will be conducted in two phases:

- Remedy screening - the laboratory-/bench-scale phase of the program

TABLE 3-1 POTENTIAL ARARs AND TBCs FOR THE SOIL WASHING TREATABILITY TEST

Regulation	Citation
FEDERAL	
Atomic Energy Act of 1954, as amended	20 CFR 960 - 962
Radiation Protection Standards	40 CFR Part 191
Nuclear Regulatory Commission Standards for Protection Against Radiation	10 CFR Part 20
Clean Air Act, as amended	40 CFR Part 50
National Primary and Secondary Ambient Air Quality Standards	40 CFR Part 50
National Emissions Standards for Hazardous Air Pollutants (NESHAP)	40 CFR Part 61
National Primary Drinking Water Regulations	40 CFR Part 141
National Secondary Drinking Water Regulations	40 CFR Part 143
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, or Disposal Facilities	40 CFR Part 264
Land Disposal Restrictions	40 CFR Part 268
Identification and Listing of Hazardous Waste	40 CFR Part 261
Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262
Endangered Species Act	50 CFR 402
Discharge of Treatment System Effluent	DOE 5400.xy
Radiation Protection for Occupational Workers	DOE 5480.11
Safety Requirements for the Packaging of Fissile and Other Radioactive Materials	DOE 5480.3
Radioactive Waste Management	DOE 5820.2A
Residual Radioactive Material as Surface Contamination	U.S. NRC Regulatory Guide 1.86
STATE	
Model Toxics Control Act (MTCA)	WAC 173-340
Minimum Functional Standards for Solid Waste Handling	WAC 173-304
Surface Water Quality Standards	WAC 173-201
Benton-Franklin-Walla Walla Counties Air Pollution Control Authority	General Req. 80-7
Radiation Protection of the Public and the Environment	DOE 5400.5
Air Pollution Requirements	WAC 173-400
Emission Limits for Radionuclides	WAC 173-480
Dangerous Waste Regulations	WAC 173-303

- Remedy selection - the integrated pilot-scale demonstration of the soil washing process.

In remedy screening, three types of processes will be investigated: wet screening, attrition scrubbing, and chemical extraction. The remedy screening phase is further subdivided into two stages. Stage I testing consists of a series of small laboratory-scale, screening level tests on each of the three process types. Stage I includes testing of a wide variety of process conditions to determine which show promise in achieving volume reduction objectives. Stage II testing will then be used to optimize and verify the most promising process types and conditions (from Stage I testing). The Stage II tests will also investigate heap leaching and wash water treatment.

Results from the Stage II studies will define the effectiveness of physical soil washing and will demonstrate those extraction reagents and concentrations that are most effective in removing contaminants from selected soil-size fractions. These remedy screening results will, in turn, be used to define and design the remedy selection testing of the integrated soil washing system. Each of these stages are described in detail in Sections 4.3 and 4.4.

The remedy selection phase of the treatability testing consists of an on-site pilot-scale demonstration of the integrated soil washing process. All components of the soil washing treatment train will be tested including feed preparation, soil washing, and treatment or containment of all secondary wastes such as water treatment residuals and residual soil fines.

4.2 SOILS USED IN THE SOIL WASHING TREATABILITY STUDY

Soils from the source trenches with the highest levels of contamination will be used for treatability testing. Historical data indicates that the maximum contamination in trenches lies near the inlet end and approximately 20 feet below grade (Dorian and Richards 1978). Therefore, test samples will be obtained by digging a test pit at the inlet end of the selected trench using a backhoe. When the pit is within a few feet of the expected maximum contamination depth, each bucket-load of soil will be placed separately on a prepared surface and field-screened for radionuclides. Excavation will continue until the radioactivity levels begin to decrease. Based on this sampling methodology, the soil horizon with the highest radioactivity levels will be selected for treatability testing. All other material will be returned to the test pit. Soils will be screened for contaminants of concern before being sent to the test laboratory.

Westinghouse Hanford will be responsible for obtaining soil samples for treatability testing. PNL will characterize the soils, dispose of residuals, and manage data from the remedy screening test in accordance with Section 3.2 of Appendix A. Westinghouse Hanford will also be responsible for providing temporary containment units and disposing and/or providing additional treatment of contaminated residuals, generated during remedy selection testing, as prescribed in the operable unit work plans or Record of Decision (ROD).

4.3 REMEDY SCREENING - STAGE I

The objectives of the Stage I screening of chemical and physical separation are listed as follows:

- Identify the distribution of contaminants and weight percent within the selected particle size fractions of the soil
- Demonstrate the effects of attrition scrubbing on contaminant removal from the larger fractions of the soil
- Identify extraction solutions that dissolve (leach) the contaminants from the soil matrix.

The laboratory-/bench-scale experiments in this stage of testing are strictly of a screening nature in that they are not aimed at meeting soil treatment criteria, but at identifying the physical and chemical treatment options that merit further study. Stage I treatability tests will consist of:

- Two types of physical separation tests
  - Particle size separation
  - Attrition scrubbing.
- Chemical extraction tests to identify effective extractants.

The following subsections describe the data to be obtained in these tests.

4.3.1 Soil Sample Collection/Preparation

Westinghouse Hanford will obtain bulk soils, package them, and ship them to PNL for testing. PNL will homogenize the samples and screen them to remove cobbles and debris (the +1.5 cm fraction). PNL will perform an initial characterization of the bulk soil. That characterization will include:

- Moisture content, specific gravity, particle size distribution, total organic carbon (TOC), and cation exchange capacity (CEC).
- Petrographic studies to qualitatively determine the degree of weathering and aggregation, heterogeneity, presence of coatings, surface texture of particles, particle shapes, and nature of parent material. Fine silt and clay-sized particles will be studied using X-ray diffraction to semi-quantitatively estimate mineralogy.

4.3.2 Physical Soil Washing Tests

The Stage I physical soil washing tests involve two separate studies:

- The distribution of contaminants on the soil will be determined by screening a soil sample into several size fractions and analyzing each fraction.

- The effect(s) of attrition scrubbing on soil contaminant levels will be evaluated by scrubbing the soil, screening out any fines (minus 0.075 mm particles), and analyzing the two fractions.

4.3.2.1 Soil Particle Size Separation. The soil (after oversize removal) will be separated into four size fractions:

- Fine pebbles (-1.5 cm to +2 mm)
- Coarse sand (-2 mm to +0.25 mm)
- Fine sand (-0.25 mm to +0.075 mm)
- Silts and clays (-0.075 mm).

This separation will be accomplished by wet or dry screening of a sample of the soil using standard laboratory stainless steel wire screens. Each screen fraction will be air dried to constant weight and submitted for analysis as defined in Appendix A for Stage I tests.

4.3.2.2 Attrition Scrubbing. Some of the contaminants in the soil may be physically attached to the coarser particles. These may be in the form of metal oxides, coprecipitated carbonates, or other compounds. Attrition scrubbing may remove these deposits. The attrition scrubbing tests will be performed in equipment appropriate for the size distribution of the soil or soil fraction.

After the treatment in the attrition scrubber, the soil will be wet screened on a 0.075 mm screen (200 mesh) to separate the fines from the larger fractions. Additional water will be required for this step.

The soil, the fine fraction, and the wash water will be analyzed as described in Appendix A.

4.3.3 Chemical Extraction Tests

The purpose of the Stage I chemical extraction tests is to identify extractants with the potential to dissolve (leach) contaminants from the soil matrix. The initial conditions, extractant concentration, temperature, and extractant-to-soil ratio selected for these tests will be aggressive. The most effective extractants from this testing will be then be investigated at more practical conditions. Some examples of possible extractants are listed as follows:

- Mineral acids

- Bases such as sodium hydroxide and sodium carbonate
- Salts such as calcium chloride and ammonium acetate
- Chelants including EDTA, glucuronic acid[2], and proprietary reagents such as Citraclean™
- Surfactants which can act as conditioning agents for the fines.

Because a significant fraction of the soil is larger than 0.9 cm, the sample size used in the screening tests should be large enough to provide consistent composition from test to test. Sample size should be sufficiently large that a chance uneven distribution of the larger particles does not skew the results. Alternatively, to provide a uniform consistent feed for the tests, the minus 2 mm fraction of the soil could be used. It is assumed that extractants found to be effective on the fine soil fraction will also perform well on the larger soil particles.

These tests will be conducted by continually mixing the soil with the extractant for several hours. After treatment, the soil will be recovered from the extractant by filtration and washed once with water. The treated soil will then be dried and analyzed as described in Appendix A. The spent extractant and wash solutions will be combined and analyzed as specified in Appendix A.

4.3.4 Sampling and Analysis

Sampling and analysis requirements are specified in Appendix A. The analytical methods chosen must have detection limits lower than the performance levels listed in Tables 1-1 and 1-2. All of the analytical work will be performed by PNL.

4.4 REMEDY SCREENING - STAGE II

The testing in this phase will be performed on either a laboratory- or bench-scale, with the scale determined by PNL. The objectives of the Stage II screening phase are as follows:

- Identify the optimum combination of chemical and physical treatments to maximize volume reduction of the original soil mass. The desired result is a clean material that meets the performance criteria for on-site backfill (See Section 1). These performance data will be used in a cost/benefit analysis which will form the basis for a decision on proceeding to the remedy selection phase.

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[2]Glucuronic acid has been shown to be effective at removing strontium-90 from mineral soils (Francis 1978).

- Determine the extraction temperature required for effective chemical soil washing

- Identify waste water treatment required to meet discharge performance levels for spent extractants and wash waters. Discharge performance levels for liquid waste streams are defined as WHC-CM-7-5, Part F, limits for radionuclides and SDWA MCLs for chemical contaminants.

- Determine the weight fraction of the original soil recovered as clean soil, contaminated fines, and other process residuals

- Determine the effectiveness of washing solution additives, expressed as amount of contaminant removed per amount of soil treated, and volume of washing solution used

- Characterize soil washing process residuals, including contaminated fines, water treatment sludges, and cleaned soil materials. This characterization shall include TCLP analysis of solids.

- Determine if heap leaching can produce soil meeting the treatment performance criteria.

The Stage II remedy screening testing will include a process optimization phase and a process verification phase. The process optimization phase will be designed to identify the physical and chemical treatments that are both practical and effective. In the process verification phase, the most promising combinations of physical and/or chemical treatment options, as determined in the Stage II optimization phase, will be tested using larger quantities of soil (quantity determined by the test contractor). These tests will generate sufficient sample quantities for more complete analysis and also sufficient wash water or spent extractant for water treatment studies.

The Stage II program will also include testing of a heap leaching process.

The following subsections describe the general types of tests that will be required during Stage II.

4.4.1 Physical Separation Optimization

Several of the physical separation tests described in the Stage I program (See Section 4.3) will be repeated with larger quantities of soil, with different soil fractions, or in combination with chemical extraction.

Wet screening will be performed on sample sizes adequate to provide feed material for the Stage II tests. The soil particle size separation test will determine the distribution of the contaminants among the soil fractions. Other wet screening tests may include the addition of the more effective chemical extractants (from Stage I) to the water used in the wet screening procedure. For these chemical extraction tests, the soil and extraction solution will be agitated for several hours prior to the screening. Soil fractions and wash water will be analyzed as described in Appendix A.

If the Stage I tests show that attrition scrubbing decreases the contamination level of the soil, this technique will be tested in Stage II on a larger scale and on different size fractions. Similar to the Stage I tests, the soil will be processed through the attrition scrubber and then wet screened to remove any contaminants separated from the surface of the soil. Soil and wash water fractions will be analyzed in accordance with Appendix A for Stage II, process optimization tests.

If Stage I tests show that attrition scrubbing alone does not reduce the contamination on the soil to acceptable levels, attrition scrubbing may be combined with chemical extraction. The scrubbing procedure can be repeated with the more effective chemical extractants instead of water. Soil fractions and wash water will be analyzed in accordance with Appendix A.

4.4.2 Chemical Extraction Optimization

In addition to the combination of physical and chemical separation processes, Stage II testing will include optimization of extraction conditions. This involves testing the most effective extractants at less aggressive, more practical conditions, including lower concentrations, dose rates, and temperatures than the Stage I tests. The optimization phase may also test the effectiveness of sequential or multiple extractions of soil by different chemicals.

Each extractant will be tested at several conditions (number determined by PNL). Extraction procedures and analysis will be identical to the Stage I testing. If the Stage I data indicate that no one extractant is likely to be effective on all contaminants, sequential or multiple extractions using different chemicals can be tested. To compare these two series of tests, they will be performed on the same feed soil or soil fraction.

4.4.3 Remedy Screening Stage II - Process Verification

The data from the initial Stage II optimization testing will be reviewed and several of the most promising combinations of treatment steps will be repeated. These will probably include both physical and chemical treatments. The purpose of these tests is to verify the integrated performance of the selected treatment processes, to generate sufficient quantities of treated soil for more complete analysis, and to produce wash waters or spent extractants in sufficient quantities for contaminant removal or wash water treatment studies. Treated soil and residuals from these experiments will be analyzed using methods for chemicals and radiological constituents (See Appendix A, Stage II, process verification test analysis).

Chemical mass balances will be performed using the analytical data from the soil washing tests. This will define the redistribution of contaminants which occurs during soil washing and will provide estimates of sorption and distribution coefficients. The mass balance approach provides a means of checking the completeness and accuracy of the measurements.

4.4.4 Heap Leaching

Heap leaching will be tested in extraction columns. The column size will be selected by the treatability test contractor appropriate for the particle size distribution of the soil. The extractant solution will be distributed over the surface of the soil to percolate through the soil column. In the initial tests, the extractant flow will be continuous using fresh extractant for each test, i.e., extractant is not recycled. Several pore volumes of extractant will be run through the soil. Leachate samples will be collected at appropriate intervals and analyzed for contaminants of concern (See Appendix A). Following extraction, the soil will be washed with water and analyzed.

The choice of extractants will be based on the results of the previous chemical extraction tests, i.e., only those which are shown to be effective extractants will be tested in the heap leaching tests. The effect of extractant loading rate, or residence time in the soil, on contaminant removal may also be investigated.

If the initial tests using once-through extractants show that heap leaching is a viable option, another set of tests will be run to evaluate recycling to maximize chemical utilization. This set of tests will be performed using the most effective heap leaching extractant as determined in the once-through tests. Recycle ratios will be determined by the test contractor.

4.4.5 Treatment of Wash Water or Spent Extractants

The treatment method used on the wash water or spent extractants will depend on the contaminants and chemicals and their associated concentrations in the water. The contaminants will be materials washed from the soil matrix and can include constituents such as:

- Chromium
- Radionuclides
- Soil carbonates
- Iron compounds
- Other soil mineral components
- Humic materials.

Spent extractants may include such chemicals as mineral acids and chelating agents.

Common waste water treatment technologies will be considered for application to wash water treatment. These include chemical reduction/precipitation, ion exchange, or combinations of these. Testing of these technologies will be carried out in two rounds. The first round of tests will screen multiple process conditions to find those which potentially meet treatment objectives. The second round of tests will be run using larger sample sizes to optimize conditions and generate process data such as chemical consumption and characteristics of waste residuals. Specifics of each round of testing are described in the paragraphs below.

The first round of tests will consist of laboratory-scale tests using water samples up to one liter in size to screen treatment techniques such as chemical reduction/precipitation and ion exchange. In these tests, the water will be treated in laboratory glassware, then filtered and analyzed for indicator contaminants (See Appendix A, Stage II, process optimization test analysis). Screening tests will be reviewed and the most effective combination of processes and process conditions will be taken to the second round of testing.

For testing of chemical reduction/precipitation, choice of chemical reagents will be based on the makeup of the waste stream and may include:

- Lime
- Carbonates
- Caustic
- Proprietary ferrate ion compounds (e.g., Analytical Develop Corporation's Truclear™)
- Co-precipitation using iron compounds and alum, and
- Polymers for flocculation.

Selection of specific chemical reagents will be made by PNL.

The second round of testing will consist of bench-scale tests of the more effective processes and process conditions determined from the first round of testing and using larger sample sizes (sizes determined by test contractor). The objectives of this round of testing are to determine optimized process requirements which maximize recovery of contaminants and generate data on the quantity and characteristics of residuals produced (e.g., precipitation sludges, spent ion exchange resins, and ion exchange regenerant solutions). Analysis shall be as specified in Appendix A for Stage II, process validation tests.

4.4.6 Remedy Screening Treatability Report

At the completion of the remedy screening phase, a screening report describing the results of this testing will be submitted to Westinghouse Hanford. This report will document the details of the testing and will include recommendations for the remedy selection pilot-test phase, including design of the pilot-scale system (See Section 8.0).

Following the remedy screening studies, a cost/benefit analysis will be performed by Westinghouse Hanford to assess the overall technical and economic viability of the soil washing process relative to its benefit in reducing soil waste volume requiring disposal. This cost/benefit analysis, using data provided by the remedy screening study, will form the basis for a go/no-go decision on proceeding with the remedy selection pilot-scale testing.

In the event that a pilot-scale study is not warranted, a contingency treatability study will be conducted as agreed to by the parties of the Tri-Party Agreement. If necessary, details of this test will be provided in a separate test plan to be prepared at a later date.

4.5 REMEDY SELECTION

The remedy selection phase of the treatability testing is an on-site pilot-scale demonstration of the integrated soil washing process. All components of the soil washing treatment train will be tested. This will include feed preparation, soil washing, and treatment or containment of all process residuals (such as contaminated ion exchange resins, water treatment sludges, and residual soil fines). Analyses will be performed as described in Appendix A.

The pilot-scale system will, based on the results of the remedy screening testing, combine physical separation and chemical extraction into an integrated process system. The system will be designed with sufficient configurational flexibility for testing a number of combinations or sequences of physical and chemical separation steps. Performance data can therefore be obtained for different process alternatives so that comparative engineering evaluations can be made.

Requirements for the pilot-scale testing are listed as follows:

- The tests will process the full size range soil on a continuous basis at approximately 10 to 20 tons/hour.
- The system will be operated continuously for a sufficient period of time to demonstrate operating reliability at steady-state conditions.
- The system will include a wash water treatment unit.
- Waste liquid streams will be recycled after treatment to the extent possible.
- Soils will be sampled and analyzed before and after testing (See Appendix A).
- Process residuals and cleaned soil material will be characterized as to physical and chemical characteristics (including TCLP analysis), and quantity produced.

The objectives of the remedy selection testing are to:

- Demonstrate that treated soil from the selected process can consistently meet the performance limits for the contaminants of concern

- Demonstrate the overall volume reduction that can be achieved with the optimized system

- Demonstrate whether wash water and/or extraction solutions can be recycled and, if so, identify the parameters that must be monitored to control solution bleed rate, i.e., contaminant or extraction concentration, pH, or other solution chemistry

- Determine the requirements of the waste water treatment system including the efficiency of treatment chemicals and ion exchange resins in removing contaminants from the wash water

- Demonstrate mechanical reliability of the equipment selected for the soil washing system

- Provide data on performance of the process equipment to allow confident scale-up to a full-scale system (e.g. >100 tons/hr)

- Demonstrate decontamination of the oversize material that was too large to be studied in the laboratory- and bench-scale tests

- Determine operating utility requirements (chemical consumption, power, water, etc.)

- Determine emissions and/or environmental impacts.

4.5.1 Pilot System Design

The design of the pilot system will be determined by the results of the process verification testing during the remedy screening phase as documented in the remedy screening report. The equipment selected for the pilot system will be down-sized versions of commercial full-scale process equipment. The operating data from the equipment selected must be scalable to full-sized units. The pilot-scale process will integrate all aspects of the proposed treatment process so that the effect of subsystem operating parameters on total process performance can be demonstrated.

The contractor responsible for the pilot-scale program will provide a design package for Westinghouse review and approval prior to installation. This design package should meet the requirements of the *Standard Engineering Practices* manual (WHC 1988b) which establishes engineering practices to ensure uniform methods for all engineering tasks and should include at a minimum:

- A process flow diagram and description of the proposed process; the process description should include a section on the operating strategy of the system.
- A list of all major equipment in the system and the rationale for its selection
- An equipment layout drawing
- A description of requirements for utilities, including steam, power, waste disposal, and process water
- A description of provisions for containment of spills/leaks.

4.5.2 Pilot-Scale Test Program

A detailed test plan will be provided by the pilot-scale test contractor which will describe the operation and test strategy for the pilot system. This document should include:

- An experimental matrix of proposed runs and test conditions
- A description of provisions for control of fugitive emissions including dust control practices
- Operating procedures for major equipment and subsystems; these procedures should include data sheets showing the operating parameters to be recorded during the runs.
- A Sampling and Analysis Plan (SAP) for the testing
- A Spill Control and Countermeasures Plan
- A description of test-specific modifications required to the operable unit Health and Safety Plan (HSP) and the Quality Assurance Project Plan (QAPjP).

5.0 EQUIPMENT AND MATERIAL

A variety of equipment, materials, and reagents will be utilized in conducting the soil washing treatability studies and performing the associated analyses. The candidate reagents for the initial chemical tests are discussed in Section 4.3.3. Table 5-1 lists the types of equipment which will be required for both the remedy screening and remedy selection tests. This list is not detailed or all inclusive. Specific equipment items and quantities will be specified by the treatability test contractor(s).

TABLE 5-1 EQUIPMENT AND MATERIALS[1]
PROVIDED BY TEST CONTRACTOR(S)
Measuring Equipment, such as: pH Meters Thermometers Balances Hydrometers
Containers
Reaction Vessels and Tanks
Standard Testing Sieves and Sieve Shakers
Drying Oven (for drying soil samples)
Physical Separations Test Equipment, such as: vibrating shakers, attrition scrubbers, feeders, scalping, and trommel screens
Chemical Extraction Test Equipment
Heap Leaching Test Equipment, including elutriation columns
PROVIDED BY WESTINGHOUSE HANFORD (for pilot-scale testing)
Front End Loader and/or Backhoe
Water Trucks (to provide process water and dust control)
Portable Restrooms
Portable Eye Wash Stations
Portable Showers
Water
Waste Disposal Containers
Protective Clothing (as required)
Decontamination Equipment
1. This equipment list does not include analytical instrumentation for leachate analyses, equipment for TCLP analysis, or general laboratory equipment.

6.0 SUPPORTING DOCUMENTATION

Much of the supporting documentation for this test plan is included in the 100-BC-1 and 100-DR-1 Operable Unit RI/FS Work Plans (DOE-RL 1991b and c). While these work plans primarily cover RI Phase I investigations, much of the supporting documentation is applicable to treatability testing as well. Supporting documents in the work plans include a Field Sampling Plan (FSP), a QAPjP, a HSP, and a Data Management Plan. The Data Management Plan is supplemented by Environmental Investigation Instruction (EII) 14.1, "Analytical Laboratory Data Management" (WHC 1988c). These supporting plans will be applicable to all work scope performed by Westinghouse Hanford including the collection of soil test samples and operation of the pilot-scale systems.

A treatability test-specific SAP and QAPjP will be prepared for the soil washing tests by the test contractor for the laboratory-/bench-scale portion of the program. These documents should use the work plan versions as a basis for plan development with test-specific modifications as necessary. All work performed on the Hanford Site will follow the OU QAPjP and SAP (modified to include test-specific requirements). The treatability test-specific SAP and QAPjP will specify methods and procedures to be used and DQOs to ensure consistency. The QAPjP must meet the requirements of the *Environmental Engineering, Technology, and Permitting Function Quality Assurance Program Plan* (WHC 1990).

Community relations activities in support of this treatability test will be performed as specified in the Tri-Party Agreement (Ecology 1989). Westinghouse will also prepare a Hazardous Waste Operations Permit (HWOP), Radiation Work Permit (RWP), and safety assessment prior to initiation of field activities. All activities are to be performed as specified in these documents.

7.0 RESIDUALS MANAGEMENT

Analysis will be performed on all waste forms (solids and liquids) generated from the treatability study program as discussed in Section 4.0. The analytical data will be used to characterize the waste for disposal in accordance with the ROD.

All tests covered by this plan will be performed on the Hanford Site, therefore the wastes will be managed and disposed as described in the appropriate EIIs. Some of the waste materials generated from these tests will be held for further testing as described in the program plan (DOE-RL 1992b). Liquid wastes (such as wash water), not being stored for further testing, will be evaporated and the residuals managed as specified in the EIIs. Specific Westinghouse EIIs include:

- EII 4.3 (WHC 1988c) establishes a system to control the containment, labeling, and tracking of waste generated during CERCLA and other past-practice waste site environmental investigations, site characterizations, and well maintenance activities.

- EII 4.4 (WHC 1988c) provides the methods to meet requirements for control and storage of radioactive materials and applies to radioactive materials generated during operations managed by Westinghouse Hanford.

Specific requirements for the different types of residual materials are discussed in the sections below.

7.1 TREATABILITY STUDY RESIDUALS

7.1.1 Remedy Screening

Washed soil, from Stage I and II treatability tests, meeting performance criteria shall be returned to the site from which it originated and placed as clean fill. Any materials not meeting the performance criteria will be stored in 55-gallon drums for future testing (such as solidification/stabilization), in accordance with procedures detailed in Westinghouse EII 4.3 and 4.4 (WHC 1988c). The number of drums will be defined by the treatability test contractor. The drums will be placed in an appropriate storage location, defined by Westinghouse Hanford, after tests are completed. Any waste or residue shipments will comply with Department of Transportation (DOT) regulations.

All aqueous streams from the treatability study program, including washing, leaching, and filtering solutions will either be placed in 55-gallon drums, over-packed (by the treatability test contractor), and stored at a location designated by Westinghouse Hanford, or be handled by the test contractor per existing licenses and permits. All waste shipments will be transported according to DOT regulations.

7.1.2 Remedy Selection

Washed clean soil from the pilot plant will be returned to the site from which it originated. Contaminated soil, and some liquids, will be containerized or placed in suitable temporary containment units and stored on the site in accordance with the EIIs (where applicable). The stored material may be used for future analyses and/or additional treatment tests (such as solidification/stabilization or thermal desorption (DOE-RL 1992b)). All other contaminated liquids will be evaporated and the residues handled as previously described.

The containment units do not need to be permitted, however, they must meet the technical requirements of RCRA for temporary confinement of a potentially hazardous waste (40 CFR 265.250 - 257 and 40 CFR 264.250 - 258). Waste will be treated and disposed of as prescribed in the operable unit work plans or ROD.

8.0 REPORTS

Two reports will be prepared, one for the remedy screening tests (laboratory- and bench-scale) and one for the remedy selection tests (pilot-scale). The remedy screening report will document the details of the screening tests. The report will include:

- Description of tests and considerations to develop the optimized system
- Description of rationale for the soil washing process verification tests
- Description of results from all Stage I/II testing
- Data summary sheets.
- Data evaluation and interpretation to show how test results compare with regulations and performance standards identified in Section 2.0 of this test plan.
- Recommendation of a single integrated soil washing system for pilot-scale testing.

A treatability test report will be prepared after the remedy selection testing and analyses are complete. The final report will incorporate information from the remedy screening report and will include a detailed summary of the treatability test. The report will include the following as a minimum:

- Detailed description of the baseline system equipment and operating parameters (e.g., temperatures and chemistry of the soil and solutions, pH, retention times for different parts of the system, and pretreatment requirements).
- Description of the optimized system and operating parameters. This includes a discussion of the options examined and results obtained.
- Laboratory data package (including data summary sheets) and quality assurance documentation for the characterization and optimized system analyses.
- Data evaluation and interpretation to show how test results compare with regulations and performance standards identified in Section 2.0 of this test plan.
- Recommendations for future tests and full-scale implementation.

A suggested outline for the report is given in the *Guide for Conducting Treatability Studies Under CERCLA* (EPA 1989a).

9.0 SCHEDULE

Figure 9-1 presents the schedule for planning and performing soil washing treatability tests. The treatability tests will be performed from calendar year (CY) 1993 to CY 1994.

10.0 PROGRAM ORGANIZATION

The organization for performing tasks associated with the treatability test is shown graphically in Figure 10-1. Westinghouse Hanford Company Environmental Restoration Engineering will have direct responsibility for the planning, execution, and evaluation of the test. Other Westinghouse organizations will provide support as needed.

Task Name	Start Date	Duratn (Mths)
SOIL WASHING	6-Jul-92	27.8
Test Plan	6-Jul-92	4.6
Prepare Test Plan	6-Jul-92	1
WHC/PNL Review	5-Aug-92	1.4
RL/HQ/EPA/ECOLOGY Review	18-Sep-92	1.1
Issue Report	26-Oct-92	1.1
Remedy Screening Test	15-Oct-92	11.6
Test Procedures	15-Oct-92	2.3
HWOP/RWP	15-Oct-92	1.5
Excavate/Ship Samples	3-Dec-92	0.8
Perform Test	30-Dec-92	3.8
Data Evaluation	26-Feb-93	3
Test Report	29-Apr-93	5.5
Prepare Report	29-Apr-93	2
WHC Review	1-Jul-93	1
RL/HQ Review	3-Aug-93	1
EPA/Ecology Review	2-Sep-93	1.5
Issue Report	21-Oct-93	0
Cost/Benefit Analysis	22-Oct-93	3
Remedy Selection Test	1-Jun-93	17.5
Procurement	1-Jun-93	9
Safety Assessment	1-Jul-93	6
Test Activities	17-Mar-94	5
Procedures & Training	17-Mar-94	2
Perform S.W. Test	18-May-94	2
Data Evaluation	20-Jun-94	2
Test Report	21-Jul-94	4.5
Prepare Report	21-Jul-94	2
WHC Review	22-Sep-94	1
RL/HQ Review	25-Oct-94	1.5
Issue Document	13-Dec-94	0

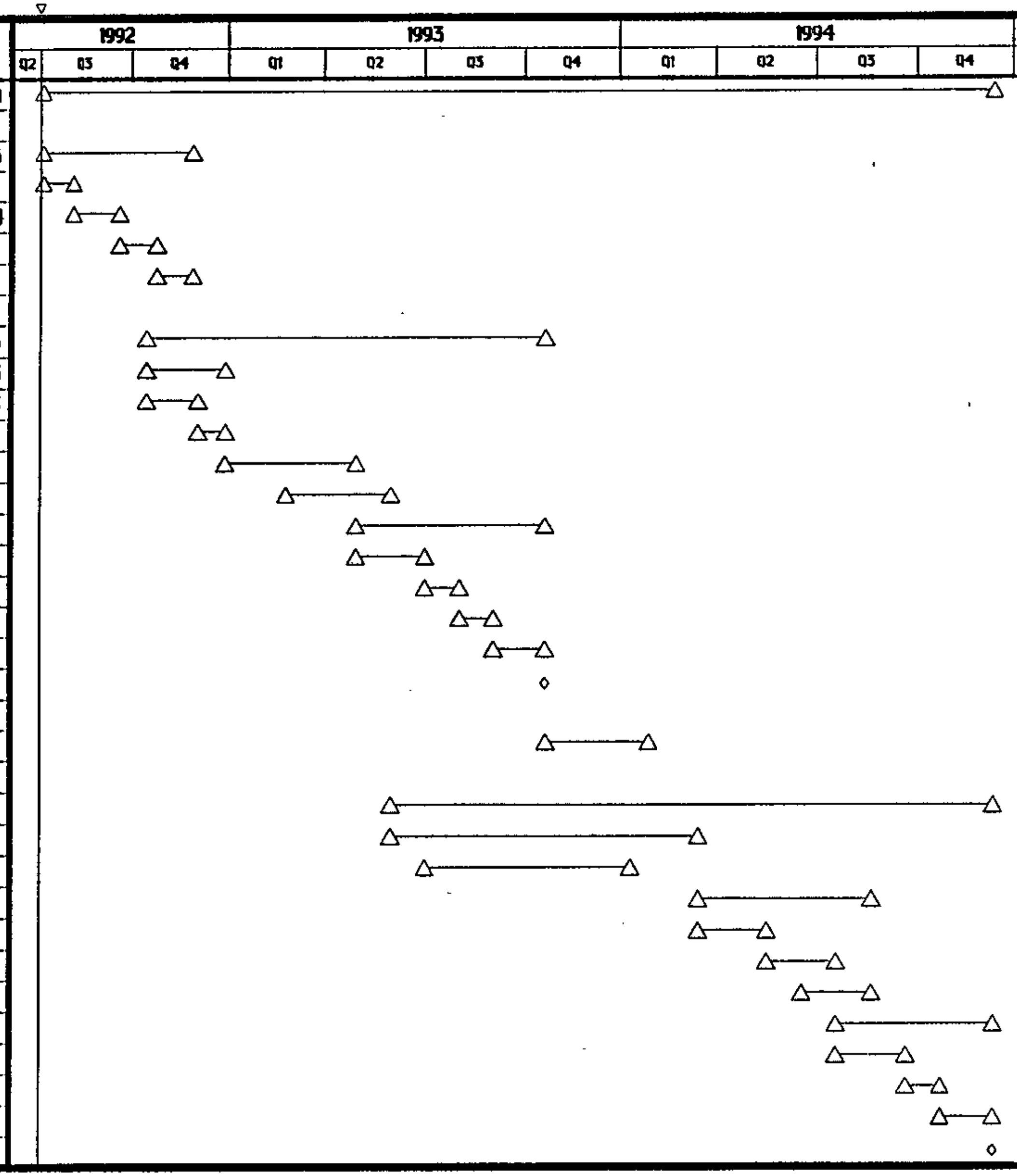

Figure 9-1 Schedule for the 100 Area Soil Washing Treatability Study

(Source: Westinghouse Hanford Company Environmental Engineering)

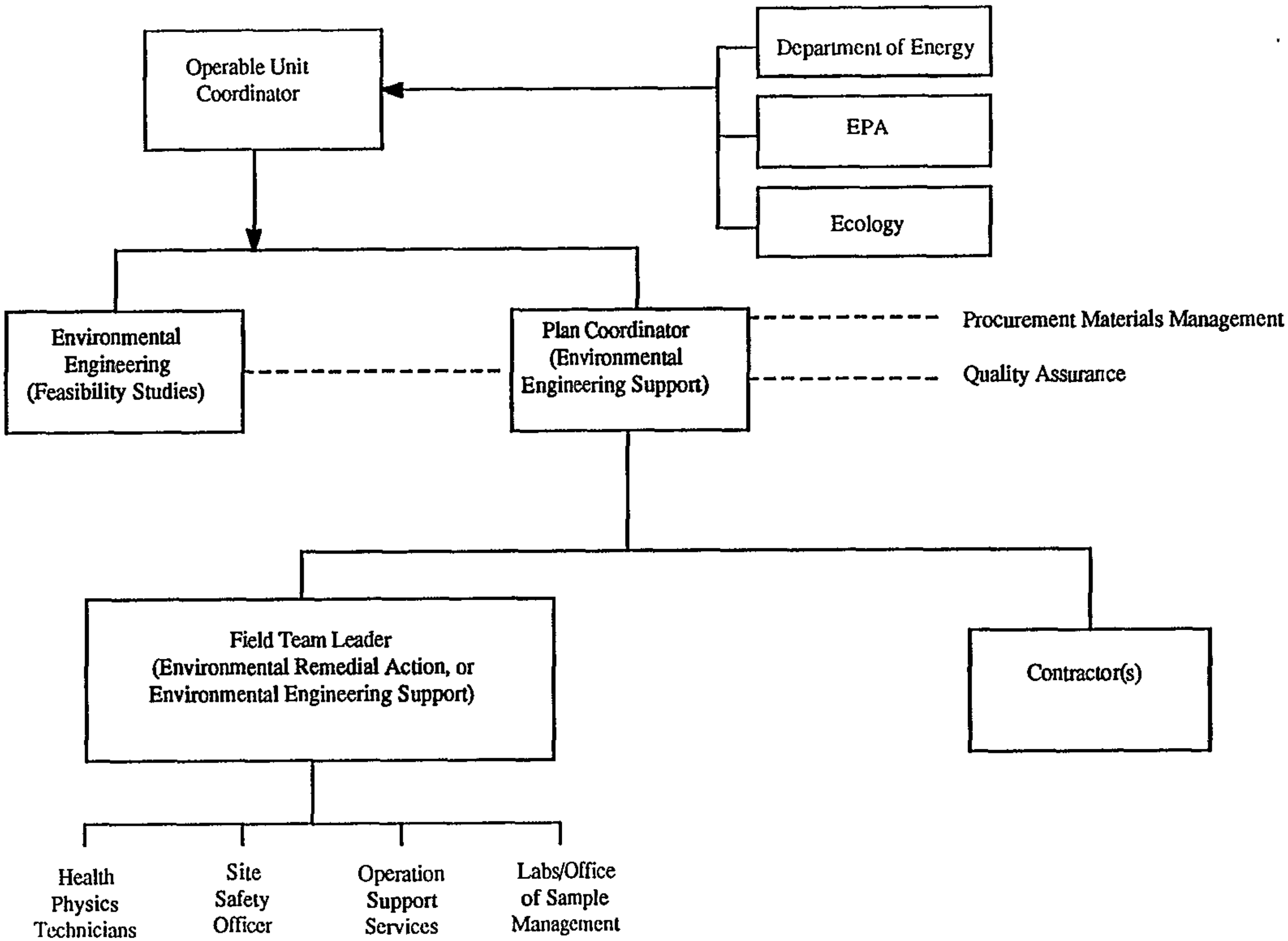

Figure 10-1. 100 Area Soil Washing Treatability Test Program Organization

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APPENDIX A

SAMPLING AND ANALYSIS REQUIREMENTS

1.0 INTRODUCTION

This appendix discusses the requirements for obtaining and analyzing samples as part of the 100 Area soil washing treatability tests. A successful soil washing treatability test requires sampling and analysis to achieve representative characterization of material both before and after treatment. The scope includes sampling and analysis for both the remedy screening and selection phases of treatability testing.

This appendix specifies the general sampling and analysis requirements for conducting the soil washing treatability study. Following contract award, the treatability study contractor(s) will, as part of the detailed procedure development, document specific sampling and analysis details in a Sampling and Analysis Plan (SAP) based upon the requirements stated in this appendix.

2.0 OBJECTIVES

The primary objectives for sampling and analysis are listed as follows:

- Determine physical characteristics of soils
- Determine the concentration of contaminants of concern in soils before and after treatment
- Determine the concentration of contaminants of concern and treatment chemicals in the process water (after treatment)
- Obtain samples and analytical results of sufficient quality to document performance of the system(s) tested and determine compliance with cleanup criteria.

Radioactive and chemical contaminants of concern are listed below. This list is derived from the respective RI/FS work plans (DOE-RL 1991a,b) and Limited Field Investigation Data (WHC 1992) for the sites whose soils are to be tested, i.e. 116-C-1 and 116-D-1B.

Radioactive Contaminants of Concern	Chemical Contaminants of Concern
^{3}H	Chromium
^{60}Co	
^{90}Sr	
^{134}Cs	
^{137}Cs	
^{152}Eu	
^{154}Eu	
^{155}Eu	
^{235}U	
^{238}U	
$^{239/240}Pu$	

3.0 SAMPLING AND ANALYTICAL METHODS

The following Westinghouse Hanford procedures will be used where applicable.

TABLE A-1
WESTINGHOUSE HANFORD PROCEDURES APPLICABLE TO SAMPLING

Subject	EII (WHC 1988)
Sampling Procedures	5.2, 5.8
Sample Handling	5.2, 5.11
Field Documentation	1.5, 5.1, 5.10
Equipment Decontamination	5.4, 5.5
Waste Handling and Disposal	4.3
Site Entry Requirements	1.1
Deviation from EII Procedures	1.4
Personnel Requirements	1.1, 1.7, 3.1
Health and Safety Requirements	1.1, 1.7, 2.1, 2.2, 2.3, 3.2
Data Management	14.1
Records Management	1.6

Note: Additional procedures are contained in *Environmental Investigations and Site Characterization Manual* (WHC 1988) that may be applicable to specific situations.

3.1 SAMPLING OF SOILS

The field collection of soil test samples for soil washing treatability studies is the responsibility of Westinghouse Hanford.

Soils from the source trenches with the highest levels of contamination will be used for treatability testing. Historical data indicates that the maximum contamination in trenches lies near the inlet end and approximately 20 feet below grade (Dorian and Richards 1978). Therefore, test samples will be obtained by digging a test pit at the inlet end of the selected trench using a backhoe. When the pit is within a few feet of the expected maximum contamination depth, each bucket-load of soil will be placed separately on a prepared surface and field-screened for radionuclides. Excavation will continue until the radioactivity levels begin to decrease. Based on this sampling methodology, the soil horizon with the highest radioactivity levels will be selected for treatability testing. All other material will be returned to the test pit. Soils will be screened for contaminants of concern before being sent to the test laboratory.

A sufficient quantity of soil will be collected from each location to supply the remedy screening treatability tests. All field activities will be coordinated by the field team leader and conducted in accordance with the Hazardous Waste Operations Permit (HWOP) and the Radiation Work Permit (RWP).

3.2 CHARACTERIZATION FOR TREATABILITY TESTING

All treatability test samples obtained during the treatability testing phases will be handled and analyzed in accordance with the contractor's approved SAP and Quality Assurance Project Plan (QAPjP) for the soil washing treatability test.

Chemical analyses for contaminants of concern shall be performed using appropriate methods, as defined by the test contractor in the test procedures. These methods shall have detection limits lower than the performance levels. Physical testing shall be performed in compliance with American Society of Testing and Materials (ASTM) procedures (ASTM 1991), and radiological analyses shall use Westinghouse Hanford approved radioanalytical procedures.

3.2.1 Remedy Screening Tests

Sample analysis for remedy screening tests can be divided into three elements: initial characterization, Stage I analyses, and Stage II analyses. Each element is discussed below.

Analysis During Initial Characterization (Pre-test)

Initial characterization tests will consist of analysis of the bulk soil for physical and chemical parameters, which include:

- Basic physical analysis (including sieve size analysis, temperature, pH, moisture content, specific gravity, particle size distribution, total organic carbon (TOC), and cation exchange capacity (CEC)).

- Petrographic analysis using petrographic microscopes and scanning electron microscopes to qualitatively determine the degree of weathering, degree of aggregation, heterogeneity, presence of coatings, surface texture of particles, particle shapes, and nature of parent material. Fine silt and clay-sized fractions will be studied with X-ray diffraction to semi-quantitatively estimate mineralogy. All these observations will help determine the association of contaminants with geologic solids and yield clues to the efficacy of physical and chemical soil washing.

- Analysis for the full list of contaminants of concern, including Toxicity Characteristic Leaching Procedure (TCLP) analysis.

These analyses will be used to document the condition of the soil prior to treatment, thus they should be of sufficient quality to be compared with the remedy screening, Stage II-verification phase results and remedy selection results.

Analysis During Stage I Testing

Stage I testing will consist of both physical and chemical analyses. Specific physical analyses will be determined by the test contractor.

Chemical analysis will consist of analysis for indicator constituents. Indicator constituents are screening level analyses appropriate for Stage I screening tests. Selection of indicator constituents will be based on full analysis of the feed soils which will determine the principal constituents whose nature and concentration levels are generally representative of the soil matrix. For example, a full radiological characterization of soil may indicate that strontium-90 and cesium-137 are the most significant contaminants among the radionuclides, representing the primary contributors to beta and gamma activity, respectively. If this is the case, these contaminants may be used as indicators. Alternatively, it may also be possible to use gross alpha, beta, and gamma activity as a representative indication of soil contamination.

Analysis During Stage II Testing

Stage II testing consists of both an optimization phase and a verification phase. Analyses during the optimization phase will be identical to analyses for Stage I testing. The objective of the optimization phase is to identify the best treatment train from a number of alternatives and thus requires only screening level analyses.

The objective of the process validation phase is to obtain high quality data to confirm the results of process optimization and compare to the initial soil analysis. Therefore, analysis for the full list of contaminants of concern, as well as for any chemical additives, will be performed. Note, however, that only those contaminants will be analyzed in test products which are found to be present in the initial soil test samples. That is, if a contaminant were not found in any of the initial test samples, that contaminant would not be analyzed in any of the test products. In addition, TCLP analysis will be performed on all solids, including fines and cleaned coarse materials.

Physical analyses will be specified and performed as needed by the test contractor.

3.2.2 Remedy Selection Tests

The specific sampling and analysis scheme utilized in the remedy selection pilot-scale testing will depend on the specific equipment systems used for the pilot-scale tests. These will be defined after Stage II testing is complete. At that time, the pilot-scale treatability test contractor will provide a detailed SAP for the system chosen. In general, the types of analysis and data quality objectives are similar to the remedy screening Stage II, validation phase, tests. Additional parameters relevant to a continuous pilot scale operation will also be monitored as an indication of pilot-plant performance. These may include the following:

- Soil feed rate
- Wash water feed rate (fresh and recycle)
- Chemical addition rate (if applicable)
- Flow rates of all products
- Physical conditions of feeds and products (e.g., temperature, moisture content)
- TCLP analysis of feeds and all solid products (including coarse material).

4.0 REPORTING

The following section describes requirements for reporting of all treatability study results and data. Included is a discussion of the methodology for analyzing data.

All data collected will be analyzed and tabulated for evaluation using the methods described by EPA (EPA 1986) and other guidance documents (Snedecor and Cochran 1980, EPA 1989). Sample results will be compared to regulatory standards to determine if samples are contaminated at levels above regulatory concern. Approved analytical procedures will require the use of standard reporting techniques and units wherever possible to facilitate the comparability of data sets in terms of their precision and accuracy.

Analytical data from sampling activities will be used primarily to determine the presence and amounts of analytes of interest in the sampled locations. Quality control reports will be submitted to the Westinghouse Hanford technical lead, and will be retained as permanent project quality assurance records in compliance with EII 1.6, Records Management (WHC 1988). The reports will compare actual analytical results with project objectives. Laboratory QA/QC manuals used for this report will be available in the project files, and reviewed for acceptance by Westinghouse Hanford. If the stated objectives for a particular parameter are not met, the situation will be evaluated, and limitations or restrictions on the uses of such data will be established. The QC report will be routed to permanent project records in compliance with EII 1.6, Records Management (WHC 1988).

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